

2019

## Session 2 - Pulmonary System

SKMC Surface Anatomy

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**Surface Anatomy Program**  
Session 2 — Pulmonary System  
Wednesday, January 31st or Wednesday, February 7th

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**Learning Objectives**

1. *Understand the location and role of pleura in normal and abnormal physiology.*
  2. *Understand the various anatomical locations of auscultation and their correlation to specific breath sounds.*
  3. *Understand what pneumothorax/hemothorax/hydrothorax are and how surface anatomy informs your procedure to fix it.*
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**Disclaimer** — *This is not intended to serve as a primary study guide for Anatomy or Clinical Skills exams. Surface Anatomy is a peer-taught mentoring program overseen by Dr. Spudich; however, the review sessions are primarily designed by MS2 Coordinators. The goal of review sessions is to highlight clinically relevant anatomical landmarks in order to reinforce lecture material. All review topics have been discussed in lecture; no new testable material will be introduced in these sessions.*

**MS2 Coordinators**

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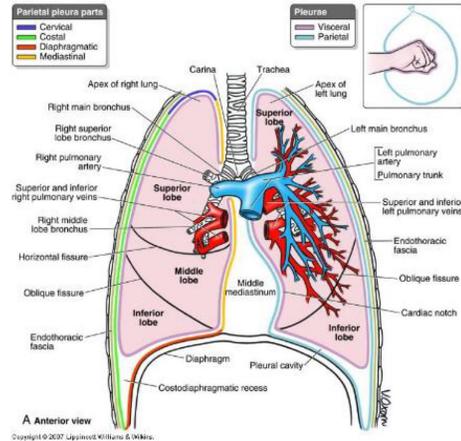
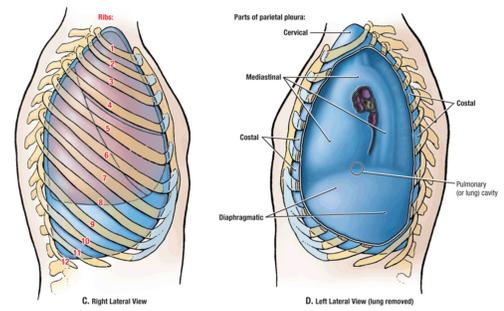
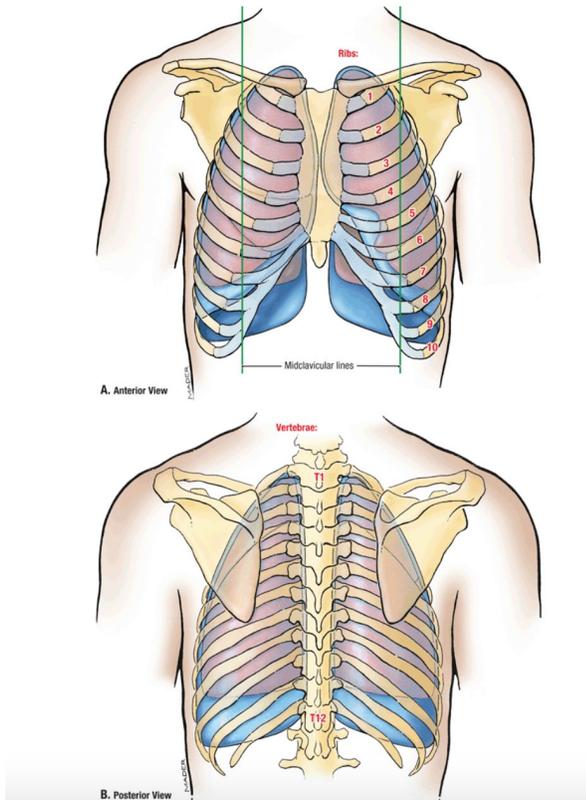
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**The surface landmarks of the lungs correspond to those of the visceral pleura.** *What is the pleural cavity? What are the two layers? Why are they useful in approximating the lung borders on surface anatomy?* (Discussion Answer Key: A)

1. **Cervical Pleura** extends through the thoracic aperture and is reinforced by the suprapleural membrane of Sibson. It covers the apex of the lungs and is the superior continuation of the costal and mediastinal parts of the parietal pleura.
2. **Costal Pleura** lines the majority of the thoracic wall. It is separated from the internal surface of the thoracic wall by the endothoracic fascia. It is continuous with the cervical and diaphragmatic portions of the pleura.
3. **Diaphragmatic Pleura** covers the diaphragm. It is continuous with the costal and mediastinal pleurae.
4. **Mediastinal Pleura** runs between the lungs and the mediastinal structures. It is continuous with the diaphragmatic and apical portions of the pleura.

**Lines of Pleural Reflection** are the locations of changes in direction of the pleura from one wall to another.

1. **Sternal Lines** are sharp, abrupt and asymmetrical. Starting superiorly, the right and left sternal lines descend together at the midsternal line from costal cartilages 2 through 4.
  - a. Right — continuous inferiorly along the midsternal line to the xiphoid process.
  - b. Left — at the level of the 4th costal cartilages, it passes to the left margin of the sternum inferior to the 6th costal cartilage.
2. **Coastal Lines** are continuations of the sternal line and occur where the costal pleura is continuous with the diaphragmatic pleura inferiorly. They slope from the 8th rib at the midclavicular line down to the 10th rib midaxillary line and continue to the neck of the 12th rib.
3. **Vertebral Lines** are rounded and gradual. They occur where the costal pleura is continuous with the mediastinal pleura posteriorly. They run in the paravertebral planes from T1 to T12.



**Pleuritis** results when the pleurae are inflamed. It is audible on auscultation and often associated with fluid accumulation called a pleural effusion. *What sounds would you hear on auscultation?* (Discussion Answer Key: B)

- When the tissue becomes inflamed, it results in a sharp pain in the chest that worsens with breathing.
- The parietal pleura is innervated by the **intercostal nerves** and the **phrenic nerve**; specifically, the phrenic nerve innervates the mediastinal and diaphragmatic regions of the pleura.
- Local pain is referred by the intercostals, while referred pain is via the phrenic nerve. *Which nerve roots form the phrenic nerve, and to what dermatomes do they correspond?* (Discussion Answer Key: C)

**Atelectasis** is the collapse or closure of a lung resulting in reduced or absent gas exchange. It is typically unilateral and may be due to a break in the parietal pleura. This break will cause the lung to collapse due to natural recoil. If fluid or gas accumulates in the pleural cavity, the “potential space” becomes a “real space.”

**Pneumothorax** — Air

**Hydrothorax** — Pleural Effusion

**Hemothorax** — Blood

**Chylothorax** — Chyle, a milky fluid containing lymph and fat droplets

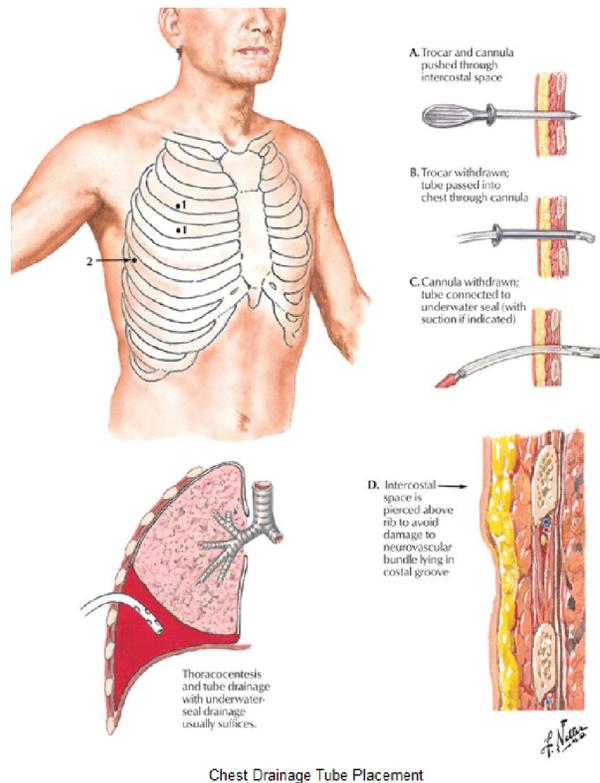
**Thoracentesis**, also known as a pleural tap, is a procedure done when there is fluid in the pleural space. It removes a small amount of fluid, as opposed to a tube thoracostomy. This tap allows a sampling for pleural fluid analysis.

- A hollow needle is inserted into the 9th ICS during expiration with the patient sitting up and the needle pointing upwards. *Where do you insert the needle in relation to the borders of the rib?* (Discussion Answer Key: D)

**Tube Thoracostomy** is often used to treat large pleural effusions, pneumothoraces or hemothoraces. The tube is inserted into the pleural cavity to relieve pressure and to allow reinflation of the lung and restoration of normal gas exchange.

- The patient should be placed in the semirecumbent position (ie, 45-90°), ideally with her ipsilateral arm raised over her head.

- The tube is inserted at the MAL in the 5<sup>th</sup> or 6<sup>th</sup> intercostal space.
- **Pneumothorax** angle the tube superiorly.
- **Hemothorax** angle the tube inferiorly.



**Aspirations** of foreign bodies tend to enter the right main bronchus; however, patient positioning can alter where the foreign bodies move. *Why do foreign bodies enter the right mainstem bronchus? Use anatomical knowledge to explain.* (Discussion Answer Key: E)

1. Upright — R Mainstem Bronchus > R Lower Bronchus > Lower Segments of RLL
2. Supine — R Mainstem Bronchus > R Lower Bronchus > Apical Segments of RLL
3. R Lateral Decubitus — R Mainstem Bronchus > R Upper Bronchus > Posterior Segment of RUL
4. L Lateral Decubitus — L Mainstem Bronchus > L Upper Bronchus > LUL

### PULMONARY PHYSICAL EXAM

1. Always auscultate the same position on the right and left sides before moving vertically.
2. Ask your patient to cough a few times before beginning your auscultation, to clear airway secretions and to open small collapsed areas at the lung bases.
3. Ask the patient to take slow, deep breaths through his mouth while you are performing your exam.



**Triangle of Auscultation** is where the lung sounds are best heard. The area is largest when a seated patient leans forward with protracted scapulae. Its boundaries are:

- Medial = Trapezius
- Lateral = Rhomboid major
- Inferior = Latissimus dorsi

**Anterior** – Auscultate in 3 positions, on the right and left sides:

1. Auscultate above the clavicle in the MCL.
2. Auscultate between the clavicle and male nipple line in the MCL.
3. Auscultate at the male nipple line in the MCL.

**Lateral** — Auscultate in 1 position, on the right and left sides:

1. Auscultate in the axilla at the level of the male nipple line in the MAL.

**Posterior** — Auscultate in 4 positions, on the right and left sides:

1. Auscultate above the clavicle in the PVL.
2. Auscultate between the clavicle and male nipple line in PVL.
3. Auscultate at the male nipple line in the PVL.
4. Auscultate at the 7th intercostal space in the MCL.

#### **Abnormal Lung Sounds Discussion**

1. *How does your differential diagnosis change when you hear an abnormal lung sound localized in one lobe, or diffusely in multiple locations bilaterally?* (Discussion Answer Key: F)
  2. *What would you hear in a patient with a spontaneous pneumothorax of the right lower lobe (RLL) caused by a 20-year history of COPD?* (Discussion Answer Key: G)
  3. *When you hear wheezes, keep listening to determine whether they are inspiratory, expiratory or both. What is a high-pitched, musical wheeze called? Do you expect an underlying intra-thoracic or extra-thoracic lesion?* (Discussion Answer Key: H)
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**USMLE Respiratory Case**  
**Adapted from Respiratory Case 17 from *First Aid Cases for the USMLE Step 1***

A 35-year-old black man presents to his primary care physician with progressive dyspnea on exertion. He has no history of congestive heart failure or asthma and has had no known contact with any individuals known to have tuberculosis.

1. What is your differential diagnosis?
2. What would you expect on physical exam?
3. What tests/labs would you like to get?

The patient's laboratory results reveal normal creatinine kinase (CK), CK-MB fraction, and troponin levels. An x-ray of the chest shows bilateral hilar lymphadenopathy and evidence of interstitial lung disease. A thoracoscopic lung biopsy reveals the presence of several small, noncaseating granulomas in both lungs.

4. What are noncaseating granulomas, and what diagnosis does their presence suggest?
5. What findings would be expected on pulmonary function testing?
6. What are some extrapulmonary manifestations of this patient's interstitial lung disease?
7. What is the most appropriate treatment for this condition?

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**Practice Questions**

1. An 81-year-old woman complained to her physician about shortness of breath (dyspnea). Physical examination in the sitting position revealed percussive dullness inferior to the fifth rib in the right midaxillary line. The diagnosis was an accumulation of fluid in the right pleural cavity. Thoracentesis was performed to remove the pleural fluid. Where would the physician insert the needle into the pleural cavity to avoid injuring the intercostal neurovascular bundle?

- A) Superior to the fifth rib, high enough to avoid the collateral branches of the intercostal nerves
- B) Along the inferior border of the fifth rib in the midaxillary line
- C) Superior to the 10th rib in the midaxillary line, high enough to avoid the collateral branches of the intercostal nerves
- D) Immediately superior to the fifth rib in the midclavicular line

2. A bicyclist comes into the ED after being struck by a vehicle. He is suffering a penetrating injury to his chest on his right side and has several cracked ribs. He is short of breath, tachycardic, and has an O<sub>2</sub> saturation of 75%. In order to alleviate this patient's pain, how would you insert a chest tube into his body?

- A) MCL - 5th or 6th ICS - Tube angled inferiorly
- B) MAL - 4th or 5th ICS - Tube angled superiorly
- C) MCL - 4th or 5th ICS - Tube angled inferiorly
- D) MAL - 5th or 6th ICS - Tube angled superiorly

3. A 25-year-old male is brought to the emergency room after suffering a stab wound to the back. He does not present with any difficulty breathing and appears awake and alert. The emergency room personnel note that there is some blood from the back near the medial and lower borders of the scapula. Which of the following statements below would NOT be correct?

- A) At this level, there is risk of injury to the lung
- B) The stab wound may be in the region of the triangle of auscultation
- C) An appropriate intervention would include a chest X-ray
- D) The inferior angle of the scapula is at vertebral level T4

4. As a general rule, the parietal pleura extends \_\_\_\_\_ ribs below the lung, giving rise to the costodiaphragmatic recess.

- A) 1
- B) 2
- C) 3
- D) 4

5. Which procedure involves insertion at the midaxillary line, into the 5<sup>th</sup> or 6<sup>th</sup> ICS?

- A) Pericardiocentesis
- B) Thoracentesis
- C) Chest tube insertion
- D) Lumbar puncture

6. What structure forms a common boundary for the lumbar triangle and triangle of auscultation?

- A) Iliac crest
- B) Trapezius muscle
- C) External oblique muscle
- D) Latissimus dorsi muscle

7. A thoracentesis is performed to aspirate an abnormal accumulation of fluid in a 37-year-old patient with a pleural effusion. A needle should be inserted at the midaxillary line between which of the following two ribs, so as to avoid puncturing the lung? *Taken from BRS (Ch 4: Thorax, Q17)*

- A) Ribs 1 and 3
- B) Ribs 3 and 5
- C) Ribs 5 and 7
- D) Ribs 7 and 9
- E) Ribs 9 and 11

8. A 5-year-old boy is brought to the emergency department because of a high-pitched sound when breathing. The child was playing with toy cars when the sound started. He is in respiratory distress, and a chest X-ray shows a right mediastinal shift and a hyperinflated left lung. Which of the following is the most likely site of obstruction?

- A) Esophagus
- B) Left lower lobe
- C) Left main bronchus
- D) Right main bronchus
- E) Trachea

9. A 28-year-old woman comes to the physician because of right-sided chest pain. Physical examination shows decreased breath sounds on the right, dullness to percussion over the right lower lung field, and decreased tactile fremitus in the same location in a sitting position. Chest X-ray shows a right pleural effusion without loculation. The patient agrees to undergo thoracentesis to sample the pleural fluid. Which of the following locations is the most likely place to insert the needle in a patient who is in an upright position?

- A) Above the 2nd rib (1st intercostal space) in the midclavicular line
- B) Above the 3rd rib (2nd intercostal space) in the midaxillary line
- C) Above the 11th rib (10th intercostal space) posteriorly
- D) Below the 2nd rib (2nd intercostal space) in the midclavicular line
- E) Below the 7th rib (7th intercostal space) in the midaxillary line

10. A 18-year-old girl involved in a motor vehicle crash (MVC) is thrust into the steering wheel while driving without a seatbelt and experiences difficulty in expiration. Which of the following muscles is most likely damaged?

- A) Levator costarum
- B) Innermost intercostal muscles
- C) External intercostal muscles
- D) Diaphragm
- E) Muscles of the abdominal wall

**ANSWER KEY**

- A. *The pulmonary cavity is invested in serous membranes called the pleurae. The visceral pleura invests the lung tissue completely, while the parietal covers the wall structures. The pleural cavity is a potential space between the visceral and parietal pleurae that contains a thin layer of fluid. The fluid maintains surface tension so that the lung surface remains in contact with the thoracic wall. This is why these reflective lines can be used to approximate the location of the lungs on surface anatomy. REMEMBER, the parietal pleura and visceral pleura are continuous at the hilum.*
- B. *On auscultation, pleuritis will present as a pleural friction rub. This sound is low-pitched, grating or creaking.*
- C. *The needle must be inserted superior to the 10th rib. This is necessary to protect the intercostal neurovascular bundle that runs inferior to rib.*
- D. *The phrenic nerve consists of C3, C4 and C5. The dermatome is the ipsilateral shoulder of the phrenic nerve.*
- E. *The right mainstem bronchus is straighter, wider and shorter than the left mainstem bronchus.*
- F. *Pneumonia is classically confined to a single lobe, whereas pulmonary edema is diffuse and bilateral. Thus, if you hear crackles and bronchial breath sounds in specifically the left lower lobe, it is unlikely that your patient suffers from generalized pulmonary edema.*
- G. *You would hear severely diminished or completely absent sounds in the RLL. Upon auscultation, absent sounds are an important finding.*
- H. *The noise is inspiratory stridor. You would expect extra-thoracic lesions, such as laryngomalacia (softening of the laryngeal cartilage), vocal cord lesions, or lesions after extubation. These produce only inspiratory stridor. Conversely, intra-thoracic lesions produce only expiratory stridor.*

#### USMLE Case Answers

1. *Asthma, heart failure, COPD, interstitial lung disease, pneumonia, psychogenic disorders.*
2. *Jugular venous distention, decreased breath sounds or wheezing, pleural rub, clubbing.*
3. *Chest radiography, EKG, spirometry, CBC, basic metabolic panel, pulmonary function studies.*
4. *Non-caseating granulomas are discrete collections of tissue macrophages, termed histiocytes, in the absence of frank necrosis or caseation (as they would appear in tuberculosis or histoplasmosis). These granulomas frequently contain multinucleated giant cells and are accompanied by alveolitis. Their presence suggests sarcoidosis.*
5. *In interstitial lung disease, lung compliance is decreased, reflecting increased stiffness from alveolar wall inflammation and fibrosis. Tidal volume and total lung capacity are typically decreased. Diffusion capacity is also decreased as a result of inflammatory destruction of the air-capillary interface. Unlike most interstitial lung diseases, sarcoidosis has features of both obstruction and restriction.*
6. *The more common extrapulmonary manifestations of sarcoidosis are in the eye (anterior uveitis) and skin (papules and erythema nodosum), but granulomas can also occur in the heart, brain, lung, and peripheral lymph nodes.*
7. *Corticosteroids.*

#### Practice Question Answers

- |      |      |      |      |       |
|------|------|------|------|-------|
| 1. C | 3. D | 5. C | 7. D | 9. C  |
| 2. D | 4. B | 6. D | 8. D | 10. E |